A STUDY ON THE PROBLEMS ENCOUNTERED WHEN USING DESIGN/BUILD IN CONSTRUCTION

by

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Submitted to the Department of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

Design/build is a delivery method that has been used lately usually in large projects in order to complete a project in a shorter amount of time and with less money. These two advantages play a priority role for the owners who can start using their product earlier and with minimum cost and for the contractors who can deliver the product faster. However, owners and contractors might focus so much on these advantages that they may overlook the problems that might occur if this method is used. They get carried away with these two pros and end up using methods for projects that are not appropriate for design/build. The author of this thesis will attempt to identify the disadvantages and the problems that exist when this delivery method is used by comparing it to traditional delivery methods. Moreover, the author briefly talks about the criteria and requirements that need to be met by the professionals involved in the project when design/build is being utilized. This particular analysis answers the question on why is it that design/build does not work in all projects in Chapter 4. In order to understand these problems, a case study on the I-15 Design/build project in Utah is done in Chapter 5. The purpose of the case study was to recognize the problems as they appeared in this project and to get an idea of what solutions were given in order to lead to a successful completion of the design/build project.

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1.1 Introduction

Browsing through various websites of construction companies one notices the frequency the term design/build is used as a method of construction. However, this is not a method that has been used only recently. According to an article by Grant McCullagh in the Construction Specifier (May, 1997), the idea of having a company that is in charge of both design and construction existed as early as 1800 B.C in ancient Mesopotamia where the code of Hammurabi supplied master builders with the tools to deal with both design and construction of projects. The master builders were at the same time architects, engineers and builders dealing with every aspect of a project. Design/build was also used on many of the great buildings and temples of ancient Greece such as the Parthenon and the Theatre of Dionysus [17, McCullagh]. The master builders of that time provided design/build services and they never thought of separating these two services.

The first time that design was separated from construction was in Italy somewhere in the middle of the 19 century. That was when design was separated from construction through laws that started to be developed. The laws also stated that the contractors for the various projects should be selected depending on who provides the lowest bid [9, Elvin]. Despite that though, design/build began to be implemented in projects as early as the 1970's

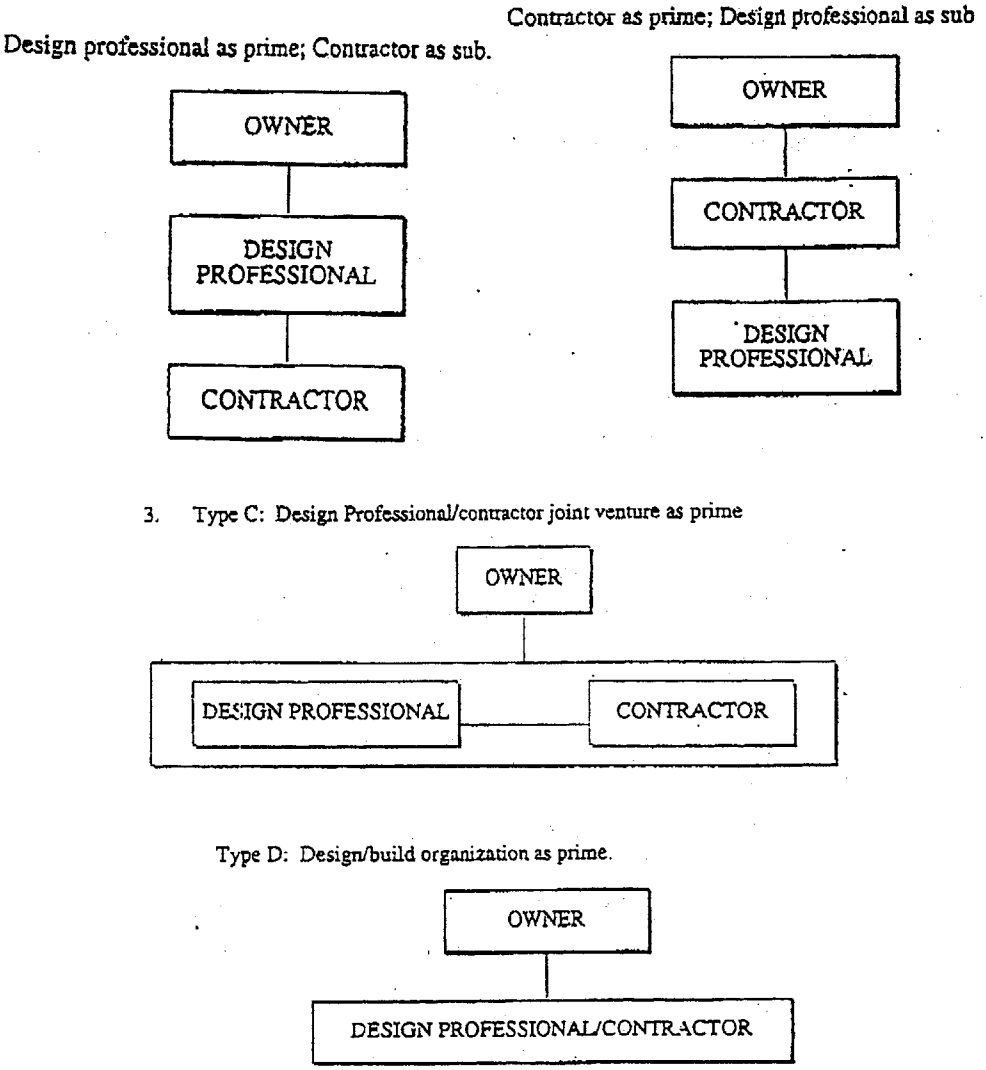
because the demand of the buildings started to increase and required that the designer worked in conjunction with the contractors.

Design/build construction is the fastest growing project delivery method in the United States and is even more popular abroad compared to other delivery methods that will be briefly described later. According to statistics that were recorded by the Design/build Institute of America and F.W. Dodge DATALINE, from April 1995 to April 1996 the number of design/build contracts increased by 103 percent over the previous years. From a total of a 212 billion dollar construction market, approximately 37.2 billion dollars were design/build. The strongest growth was within the category of: "industrial plants, refineries, factories and warehouses," in which the use of design-build increased by more than 300 percent from the previous years [21].

Design/Build is defined by "a single source entity that an owner can hold responsible for the design, procurement and construction for their product. It is not the contract but the approach. The contract itself can be in a myriad of forms from time and material to lump sum with performance guarantees [20, McMahon]." Using design/build, the owners are at the top of the pyramid and the positions of the designers and the contractors' vary. As for the organization, there are projects where the designers are the primary people in charge and the contractors are the subs or the other way around i.e. having the contractors as the people in charge and the designers as the subs. Moreover, the designers and the contractors might form a joint venture, which means that the owners communicate with a design/build organization. The hierarchy that appears when design/build is the project

delivery method used in construction is shown in the Figure 1 below. It shows that the design professionals or the contractors can be primes, a joint venture of the design professional and the contractor or the design/build organization could be the primes.

Figure 1: Design/build Hierarchy [23]



1.2 Advantages

A study that was published in January of 2003 showed that the 'benefits of design/build included 6% lower costs, 12% faster construction, 33% faster project delivery (design and construction), 5% less cost growth and 11% less schedule growth [15, Leaders]. Three main people are involved in design/build construction: the owner, the designer and the contractor. The design/build company is equipped with its own designers and contractors. The owner is the client that goes to a company because he or she wants a product to be designed and built quickly and inexpensively. The advantages could be separated in the ones related to the owners and the ones related to the contractors and the designers as listed below

1.2.1 Owner's Advantages

a) The owners only have to deal with one person. Once the owners select the company of their preference, a representative from that company is exclusively the one in contact with them and is the one who coordinates matters between the designers and the contractors. The owners deal with fewer people, which is less stressful [6, Collins].

b) The owners are released from any liability regarding the project as far as mistakes and errors. If errors occur with the project the owners can hold the company liable but have no personal responsibility. The owners are not interested into how things are done, but are only interested into the outcome and whether the project is completed on time and within budget [6, Collins].

c) Design/build reduces the time the project would otherwise take to be completed by having precise scheduling; meaning determining the critical path. The critical path refers to the logical order the activities of a project have to follow in order to not delay the completion of the project. The owners have no control over the critical path. If the critical path is disrupted, then that is something the contractors deal with. The owners are only concerned with having the product ready on time.

d) The owners are aware of the cost of the project before the project even starts. By using design/build, the cost and time of the project is reduced, which is very favorable to the owner. As the saying goes "time is money"; by completing the project faster, fewer funds are required.

e) There is a better chance for the owners to receive a product in good quality because of the coordination, cooperation and communication between the designers and the contractors. By having both work together and on site, problems and issues are more efficiently discussed and resolved. More than one person is involved with the project and each person with their experience can positively contribute to satisfy the owners. This will also reduce change orders since the designer and the contractor work under the same roof and one could point out problems in the design or construction to one another and visa versa before making any final decisions.

1.2.2 Designer and Contractors Advantages

a) Neither the designers nor the owners need to work individually. They work as a team. When a problem comes up it is dealt with within the entire design/build team. For example, during excavation, a type of rock appears in the ground making it not only difficult to excavate, but endangering the project by applying large stress to the slurry wall that is designed to be built. This pressure might only be dealt with using a thicker slurry wall. Both the contractor and the designer will solve this problem. Dialogue is easier when the people involved are face to face rather through some kind of conference call, telephone, email or fax [6, Collins]. The completion of the project is the responsibility of the design/build team. Therefore, since the owners are not involved with the construction procedure, the team could recommend to the owners methods, materials, and systems their firm is familiar with in order to be successful in the job [6, Collins]. Moreover, the contractors could apply "innovative or new technology on the project (and possibly proprietary systems or processes to achieve competitive advantage) [23]."

b) Designing while building makes the engineers aware of certain conditions on the site that they might not have been familiar with if the design were to be completed a number of years ago. This minimizes change orders, since the contractors can pinpoint key issues that need to be taken into account about the site to the designer and visa versa. Both the contractors and the designers work for the present, which is more accurate than working for the future [6, Collins].

c) The contractors are exposed to the world of the designers and the designers are exposed to the contractors' world. By experiencing closely the problems and the issues each area has to deal with, the people involved in the design/build project begin to appreciate one another's issues. Both are better informed, which leads them to decisions that will improve the quality of the project.

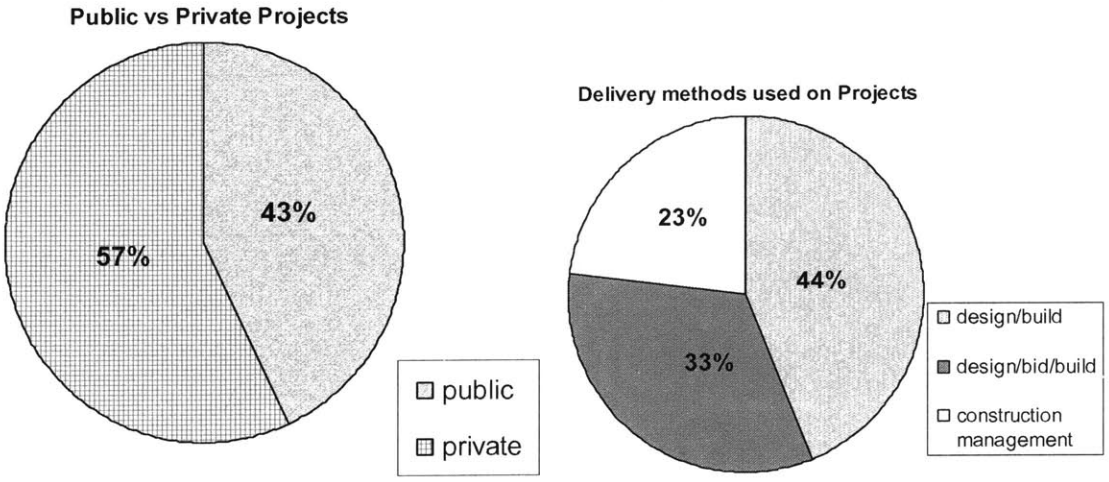
This innovative delivery method is good with larger projects that are done in phases. Large projects could be better controlled when using design/build. It is easier for the funding as well, since each phase of a project could start when the essential funding is available. With design/build, the project can continue only if the available funds are available. No design work is being done if the project stops. That way, if the project has to continue after a good amount of time, the designs are made from the beginning for the corresponding project phase. With the traditional delivery methods, if the designs were completed and the project was interrupted, then changes would have to be made on the designs in order for them to be compatible with the current conditions under which the project is being continued. With design/build, no changes would take place since the designs do not exist and are being created from the beginning.

Chapter 2

Other Innovative Project Delivery Methods

For a successful completion of a project, contractors may choose between a number of innovative project delivery systems. The most common delivery systems used on projects are the traditional method of design/bid/build, pure and at risk construction management, and design/build, which will briefly be explained. According to a summary by M. Smith for AGC/BSA Design/build committee in June of 1998, 351 general building projects were surveyed from which 43% were public and 57% were private. Out of those projects, it turned out that 44% of them were built using design/build as their delivery method, 33% were completed through the design/bid/build method, and 23% through construction management as you can see in the pie chart below in Figure 2.

Figure 2: Statistics on Delivery Methods used in Projects



Each of these delivery systems has their own characteristics and problems. This thesis will be focusing on the design/build method and specifically the problems that arise when it is used in construction, and will propose solutions to avoid those problems. However, in order to understand the design/build method, it is important to understand the other delivery systems used.

2.1 Design/bid/build

The traditional process refers to design/bid/build, where a design professional is hired to prepare the design and contract documents. Once those are completed, competitive bidding or negotiations with the contractor takes place. The owners are the people who choose the architects depending on their qualifications and on what they are interested in building. After the design is completed, the project goes out to bid and the contractors are basically the people responsible for the execution of work that needs to be done on the project and are also the ones that have to deliver the completed project to the owners. The owners are interested in constructing a product good in quality and value, with the least cost and time spent on it. The common interests the contractors have with the owners is the length of construction, and together with the architect, are interested in profit, obtaining a good reputation, as well as having good relationships with the people that are involved [24, Pena-Mora]

Design/bid/build is a method that has extensively been used in projects. One of its advantages is that the cost is defined before construction starts. The owners are protected

through a contract stating that they do not have to be too involved in the construction process. The disadvantage however is that the design is not reviewed before construction begins and the construction cannot start before the design is completed. A result of this is that the procedures during construction have to be done in order, something that does not allow overlapping activities. This leads to spending more money and time on the project [24, Pena-Mora].

2.2 Construction Management

Generally in construction management, a design and construction management firm is both hired by the owners on different contracts before the beginning of the design and construction of the project. There are two types of construction management: pure and at risk. The difference between these two is that in the pure construction management, the owners have a contract with the trade contractors, whereas in the at risk construction management, the construction manager is the one that has contracts with the trade contractors. In the pure construction management, the manager is the one to whom to refer to when conflicts occur and he or she is usually paid a fixed fee. The manager experiences a small financial risk but a high risk on the loss of his or her reputation. With the construction management at risk, the construction manager guarantees the owners that the project will be delivered within budget by guaranteeing a maximum price for the project. This results in the reduction of risk for the owners [24, Pena-Mora]

With pure construction management, there is flexibility in the schedule of the project, which means that change orders can easily be implemented. The independent contracts

allow the owners to replace a contractor if they are not satisfied with the work they are doing, without affecting the entire job. The people involved, coordinate by referring to one person, the construction manager who is the one who experiences the least financial risk. The negative aspect about this method is that whoever is hired in the beginning to work, has to stay till the end. In addition the construction managers take a high risk in loosing their reputation when choosing this method. With construction management, as mentioned earlier, the owners' risk is reduced since the construction managers are the ones who deal with the trade contractors since they have contracts with them. The disadvantage with this project delivery system is that by giving a maximum budget for the project, this puts the contractors at major risk since for the most time it is hard to complete the projects on budget [24, Pena-Mora].

2.3 Design/build

Design/Build is a construction method that differs from the ones mentioned above for the simple reason that a firm hired by the owner is responsible for both the design and construction of a project. This firm can be a design/build firm but also a joint venture for the specific project that can hire other subcontractors for the job. It is a method that has been used a lot lately in various projects because its main advantage is that the project could be delivered sooner with less money. The advantages of using this delivery system were briefly mentioned in Chapter 1, but this thesis will be analyzing the problems and disadvantages that this delivery system creates [24, Pena-Mora].

Chapter 3
Disadvantages of Design/build

Design/build may be a construction method that is complimented on most companies' websites and is lately attempted to be used as much as possible in the projects but it does not only have advantages. According to Schiff Hardin &Waite who have been involved in a large number of design/build projects there are some legal problems that exist in using this construction method. These legal issues are related to the relationships and loyalties between the individuals involved, the performance warranties, change orders, problems with licenses, insurance and bonding problems.

3.1 Relationship and loyalties among the parties involved

As mentioned earlier, with design/build both the designer and the contractor belong on the same team, come from the same company, and have common interests. This brings owners to a disadvantage since they do not really have someone on their side during the construction process of the project to make sure that everything is being done as they wish. In the traditional design methods, the designers are their own entity and are under their own contract. Therefore, the designers act as representatives of the owners during construction and make sure the design made that was approved by the owners, is followed during construction. With design/build the owners do not have control over the process that is followed during construction since they are only interested in the final product. The contractors represent the design/build firm; serve the goals of the firm and

work towards what the design/build team wants to accomplish having in mind what the owners asked for. During construction, if problems come up, it is the contractors' responsibility to inform the owners about those problems but not necessarily ask them how to resolve them. In cases like this, the contractors refer to the team's previous experience and the team deals with the problem independently.

If responsibility delegation dissatisfies the owner when using design/build, then that could be easily resolved by making things clear though the contracts before the project even starts. The owners have a contract with the design/build firm. In that contract they could make it clear that they want to be informed by the design/build firm about details regarding the progress of the projects and in general assign more responsibilities that are not usually given to them as owners. The contract represents a set of rules that have to be followed so if there is something that the owners want that differs from what is usually done in design/build, then that could be stated in the contract.

3.2 Bidding

A disadvantage that affects the owners is that with design/build competitive bidding for the project does not occur. A result of this is that the owners are not guaranteed the lowest fixed price for the project. The contracts regarding the cost of the project are created after a series of negotiations that take place between the owners and the design/build firm. 'Price is not fixed on the outset of the construction process, and negotiations after a period of time present a risk to the owner that costs for the project may begin to exceed budget after a substantial portion of design has been completed' [2].

The excess in costs may be a result of changes that occurred during construction or possible delays that occurred in activities, which resulted in having to rush other activities by working overtime, or adding more crews in order to complete the project on time. These delays might be caused because of unpredictable site conditions that occurred, equipment failure or unexpected weather conditions.

As far as preparing a bidding package for a project, it turns out to be more expensive than bidding a project with the traditional project delivery methods. With design/build the designs should be 35% completed before the project actually goes to bid, or there should be enough information in order to get a good idea of what the product will look like and what needs to be done. The reason why it is more expensive to prepare a design/build proposal than one with the traditional methods is because parts of the project will have to be completed as a part of the bidding project. In order to prevent a situation where the bidder "puts in a duplicate effort", it is recommended that the owners provide the required information necessary for the design. Required information could refer to preliminary geotechnical investigations, initial surveys, permitting studies. It is important that as much information as possible is provided to reduce the amount of assumptions the design/build companies will have to make. If little assumptions are made, this will avoid similarities in the proposals. Similar proposals will not make the owners happy because there will be no variety and it will make things harder for the owners to choose the best proposal, the one that will provide them with the best quality [10, Fredrickson].

3.3 Change & Inflexibility

Inflexibility is a characteristic of design/build construction. Everything is settled in the contracts before construction begins and it is hard to alter. The designs are not the only area where not much flexibility occurs. This appears in the construction as well. The owners do not have a choice of the construction method they wish to use. If they want their product to be delivered on time, they have to let the contractors use the methods of construction they are accustomed to using and that the contractors' company has experience with in previous projects in order to get the best results. Moreover, the owners do not separately choose designers and contractors but choose a design/build firm that has both in house. This also does not allow much flexibility to the owners. If for some reason during construction the owners are not happy with the work either one is doing, they do not have the option of choosing another designer or another contractor. The only choices that exist, would be either to hire a different design/build firm, or to try and talk to the construction manager and try and solve the problems with either the designer or the contractor.

As far as the designs, any changes will cost the owners. Even though everything should be predetermined in the contracts, change orders are expected to occur. Change orders refer to changes that have to be done in the contract in order to satisfy current conditions. With the other delivery methods that were mentioned earlier, change orders usually occur when the owners decide to make some changes on the scope of the project, or cause some kind of disruption in the process of construction of the project. Also change orders occur when some problems occur on site or in the design, problems that were not accounted for

before. With design/build construction the changes the owners are responsible for, may lead to change orders but if there are problems in the design then change orders are not the owners' responsibilities. This is because with design/build the contractor is the one in charge for the design plans and the specifications of the project so if changes in that area have to be done, then that should not be used against the owners. When mistakes and problems occur, the contractors should figure out a way to resolve them and should not hold the owners accountable in any way.

3.4 Insurance & Bonding

As far as bonding goes, in the traditional methods of construction, owners usually require the contractors to have a performance and payment bond. This requirement gets pretty complicated in design/build construction because the contractor is both responsible for the design as well as the construction. Throughout the negotiation process that takes place before the contracts are signed, it is important for the owners to ask from the design/build firm that they have hired, for a performance bond that would cover both the design and construction activities to be done by the firm. This may sound easy but it turns out not to be because the companies that provide bonds are hesitant to accept performing design responsibility for a design/build firm. The reason for that is that there are major differences between the responsibilities the designer has and the ones the contractor has. This causes problems in obtaining full coverage performance bonds. This also makes the project more expensive because additional insurance needs to be purchased in order to cover possible delays, errors and omissions that might take place during the construction of the project [2].

For design/build projects, insurance is an item that could get complicated. Initially the designer and the contractor are covered under different insurance policies. The contractor is covered under the commercial general liability policy and the designer is covered under the professional liability policy. The differences between these two insurance policies are shown in Table 1 below:

Table 1: Differences between insurance policies [8]

Commercial General Liability Policy	**Professional Liability Policy**
Refers to construction and installation of activities	Refers to the design and the construction management of the project
Losses are related to injury of the body and damage of the property	Financial losses – loses that may be caused by delays
Does not include losses due to errors in the design or omissions caused by the professionals	Include losses due to errors in the design or omissions caused by the professionals.
'Claimants, such as the occupants of a building, are typically not in privity of contract with the insured'	'Claimants, such as owners, typically are in privity of contract with the insured'

Besides these two policies, there are of course a number of other insurances that a design/build company must have such as the Construction Liability Insurance, The Workers Compensation Insurance, Automobile Insurance, Directors and Officers Coverage, Builder's Risk Insurance. However, these do not refer explicitly to the two major roles in the project; the designer and the contractor, and will not be analyzed in this thesis.

Having two different insurance policies, for these two important roles does not imply that all aspects of errors or omissions caused by them will be insurable. There are situations that could be between the two and that neither would cover. A simple example is failure in an air conditioning system of a building. The general liability insurance would cover the medical problems that the people working in the building might have, such as heat exhaustion, and the problems that may occur in certain equipment because of the increase in temperature. The professional liability insurance would cover the replacement of a damaged ceiling due to leakage of the air conditioning system or even the cost of replacing the entire air conditioning system and renting temporary equipment till the job is completed. The cost of making new plans for the new air conditioning system and the cost of replacing and removing the old system are not mentioned in neither of the two insurance policies [8].

Having two different insurance policies for the designer and the contractor is what makes matters confusing and complicated. This is because sometimes in a project it is not clear if the professionals are responsible for a problem or error or if it is the contractor's fault. Things could get really chaotic when it comes to pointing out fingers of who is responsible. This affects a project in multiple ways. For example, it may cause delays in completion because the person responsible for the error has to be found, or it may prevent from delivering the project to the owner on time because it has to be decided which insurance company has to pay for the errors. Lastly, it can also corrupt the relationship between the designer and the contractor who in most cases compose an entity; are part of one design/build firm. When the relationships between the people involved in a project

are corrupted, then the results are not the ideal ones. In order to prevent problems like the ones previously mentioned from occurring within a design/build firm, it is wise to place both the general liability policy and the professional liability policy under one insurer [8].

However, having one insurance policy for the design/build firm can also cause problems since there is a chance that overlapping may occur and gaps may still exist. If overlaps exist then that can cause increase in the price of the project since the owners will have purchased coverage for something they already have coverage for and gaps could put the owner at risk because of the lack of coverage. The owners' priority should be insurance. Just like insurance is important for medical and cars, it is of equal importance in construction. A lot could happen during construction such as, 'if a claim for design negligence arises after the project is completed and the design and construction firm have gone out of business, the owner will likely be without a source of recovery if a sufficient "tail" was not written for the policy to cover design error detected in the future. The owner could account for this risk by imposing upon the design/build entity a contractual obligation to obtain a policy that includes such a "tail"'[2].

3.5 Performance Warranties and Quality

The quality of the product is an issue that concerns most owners. When owners hire a company that uses a delivery method that is supposed to complete the project sooner than the traditional delivery methods, then that creates a major concern to the owners about the quality of the final product. The design/build company that is hired to do the work is mostly interested in keeping its good reputation by delivering the project on time and

within the estimated budget. As most businesses the company is interested in their profit and their reputation. This however creates concerns about how good the quality of the final product will be. For example, in order to stay within budget, cheaper materials of lower quality might be used; some activities might be rushed in order to make up for a delay that might have occurred. The question that this issue creates is how a design/build firm can guarantee to the owners that they are getting the desired quality hoping for. This question led to the use of performance warranties.

A performance warranty is 'a guarantee given to the purchaser by a company stating that a product is reliable and free from known defects and that the seller will, without charge, repair or replace defective parts within a given time limit and under certain conditions' [25]. Warranties are connected with liquidation damages. For example, if a design/build firm guarantees in the warranty document that a facility will yield an output of a certain number of kilowatt hours and it does not turn out to be that way, then the design/build firm will be responsible for liquidation damages.

Warranties can be short or long term depending on the size of the project, and the agreement the owners have made with the design/build company. For some of the large projects where the design-builder is responsible for the maintenance and operation of the product, it is common to have them provide long-term warranties. This of course creates the disadvantage of raising the cost of the project just because a more expensive insurance is required. The contractors raise the cost of their bids for the projects to be able to cover the expenses for the additional insurance and bonds that will be required to cover this long-term warranty. There are design/build firms though that provide short-

term warranties up to 10 years. It is important that the warranty documents are created very carefully in order for the risks to be allocated to the right people. It is also important to list in detail the errors and faults in the design or the final product that the contract will be responsible for, in order to prevent misunderstandings and problems in responsibility delegation. Some of the sections a warranty usually includes are the summary of project warranties, the requirements for the warranties, and the material and workmanship warranty specifications [11].

Projects that are executed by using the traditional project delivery methods do not require warranties because the contractor and the designer are not part of the same group. So if a problem occurs in the project, then one can blame the other for it and visa versa. In order to avoid conflicts between the members of this group, it is necessary for a design/build firm to provide the warranties. However, the contractor and the designer are not responsible for everything. There are items in the warranties for which the owners also have responsibilities. For example, for a short-term warranty, the owners would most likely be responsible for the operation and maintenance of the product. Ultimately, it turns out that having to provide a performance warranty, is a disadvantage to the design/build company for carrying the responsibility of the product for a number of years after it is completed; for the owners though, it is both an advantage and disadvantage. The disadvantage is that they have to pay a higher price for the project in order to cover the extra insurance and bond expenses but an advantage because they are getting guarantee for the quality of the product.

3.6 Licensing

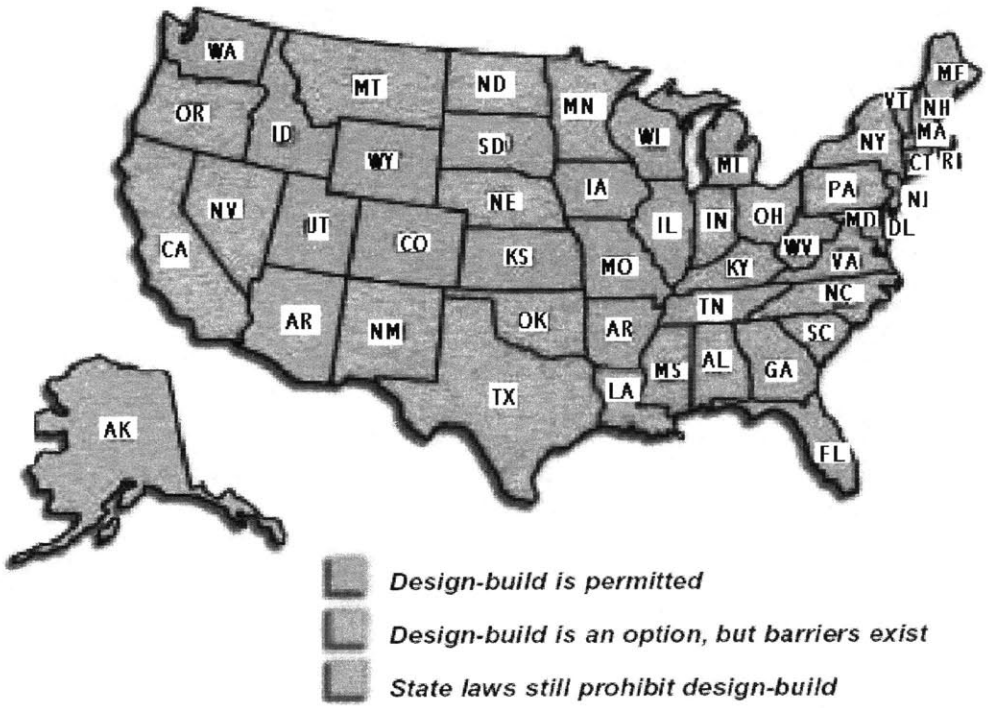
Design/build is not a construction method that has been around for a long time and that could be used in all states. The states this design method has gotten recent approval for are shown in Figure 3 below. From the figure, one could see that there are states that permit design/build and that have design/build as an option with some obstacles, but there are also states that do not permit design/build at all.

Even though there are states such as New York and North Carolina that do not permit design/build, projects have been done using this delivery method after obtaining the necessary requirements and the licenses. One example is the Light Rail project that connects the JFK Airport with the Jamaica Rail Station the New York City subway system and a number of car parking lots, which was a design/build project.

One of the requirements that the states ask for in order to allow design/build is that the design portion of the project is done by design professionals that have a license to perform activity related to design and construction. There are states that just do not allow their architects to be part of a business partnership or a joint venture where there is a non-professional person that is in charge of architectural services. Also, there are states that just do not want a business arrangement like the one with design/build unless the company that uses this delivery method has professional architects on its team. Moreover "some states have passed regulations that prohibit a nonprofessional entity or person from "brokering" architectural services, a rule possibly to preserve the architect's fiduciary duties to the owner or, at a minimum to ensure the integrity of communication between

the architect and the ultimate recipient of his or her services, the owner" [18, McCallum] If there are architects that do not follow the rules the state has regarding design/build and they go ahead and become part of a design/build process, then they maybe disciplined as aiding the unauthorized practice of architecture. The state is mostly interested in the safety of its people and by no means do they want to gamble that.

Figure 3: Design-Build gains approval in the U.S.A [19]



(Source: Design-Build Institute of America)

Another reason why the states might not allow design build is because of the reaction of the smaller design firms and contractors. With design/build, the smaller firms that consist of independent designer consultants are in danger of being out of business. When design/build is used, design/build firms are hired. They have their own in-house designers and contractors. The frequent use of design/build will take away work from the independent designers who will no longer be needed since the firms will have their own in house staff.

Every state in the United States has some requirements that contractors have to fulfill in order to use this construction method. These requirements are related to education, organization of the contractor, as well as to professional engineering and architecture. If contractors do not meet the requirements each state has specified, then they do not have a license to use design/build as a project delivery method. The architecture requirement is usually the one that they mostly lack. 'There are states that do not allow the contractor to perform professional services as part of a design/build project unless the contractor itself is a registered design professional' [21]. There is not a direct solution for the licensing issues that occurs for design/build in various states. If a company would like to have a license to be able to apply design/build on projects and to recommend this method to owners, the companies need to try and satisfy the requirements depending on the state they wish to be licensed in. Even if companies meet the requirements needed to obtain a design/build license, there still are states where design/build is not allowed.

3.7 Risk

When a contractor decides to use a delivery method that is dependant on time and schedule, there is a risk of getting the job done and completing the project on time; a risk on meeting the deadline because of unpredictable conditions that might come up during the project, conditions that might have not been accounted for. Not being able to complete the project on time is something for which the design/build entity is responsible for and at the end they will have to pay for depending on the agreement that has been made in the contract. Usually penalties are applied because the owner possibly loses revenue from the product. For example, if a hotel is done with design/build, and there is a delay, every day that it is delayed causes serious loses to the owners because they cannot start collecting revenues.

Chapter 4

Why does not Design/build work successfully?

In order for a design/build project to work successfully, there are a number of requirements that need to be satisfied in order to use this delivery method and to have positive results. It cannot be applied on every project. The projects that are considered to be appropriate are the ones that have repetitive design needs; needs that are driven by performance and where the design needs are clearly defined. Also appropriate are the ones that have a demanding schedule and highly controlled risk needs.

Design/build is a fast track method where construction can start even if the designs are not completed. In order to be able to stay within chedule when completing the number of activities, and to satisfy the advantage that design/build has i.e. to complete the project on time, it is important that the designers are aware of what exactly the owners want, aware of special conditions that exist on site in order to be able to plan accordingly and to be prepared when the time comes to design a specific part of the project. This keeps the project in an ongoing process and reduces the amount of changes that might be needed. Changes requested by the owners, are the owners' responsibility and might cost them time as well as money depending on the contract. If the scope of the project is not predetermined, then design/build is not a method that should be used because most likely, there will be problems and the project will not be a success.

Because of the fast pace of the projects that use design/build as their delivery method, it is important to have a design that is flexible to changes in order to use this method. The reason for this is because the design is being done parallel with construction. For example, if an activity of the project does not go as planned during construction, then the designs for the activity that follows need to be altered accordingly. This is because the previous phase of the project has already been constructed and cannot be changed. A simple example could be the rehabilitation of Fenway Park that one of the Masters of Engineering groups at the Massachusetts Institute of Technology worked on. They designed a new double-deck structure and the idea was to construct it using design/build as the project delivery method. They were going to place an underground parking garage below the field using the top-down construction method. If for some reason during construction the conditions of the soil found were different than the ones for which the thickness of the retaining walls were designed for, for example the soil might be applying more pressure on the walls, then that should be flexible to change.

When aesthetics is a primary concern for the owner of the project, then design/build should not be used as the delivery method. Sometimes with design/build construction, the owner 'is forced to accept a facility or structure different than that which was originally envisioned since so many different approaches to buildings exist. In, fact the owner is often forced to concede control over the details or aesthetics of a project' [2]. This ends up affecting the desired aesthetics of the project. In order to avoid this problem, a good idea would be if the owners make it clear to the contractor before signing a contract with the design/build firm, that the aesthetics of the ended product is very important to them.

If aesthetics ends up being of great importance to the owners, it would be wise not to go with design/build because the product will not end up satisfying the owners. Projects that are controlled by aesthetics and architecture should not be candidates for design/build. The fast track this delivery method has, does not allow complicated architecture designs that will be aesthetically pleasing. In order to accomplish something like that, a traditional delivery method would be more successful, since there is plenty of time to create the designs and to study ways to make the product appealing aesthetically to the environment and to the owners.

In order for design/build to work successfully, the owner cannot interfere a lot in the design and the construction of the project. The owner cannot desire early project completion but at the same time insist on actions that can delay the project such as wanting the design to be completed before the construction process starts. The owners have to be well aware of what they are getting into when choosing design/build as a project delivery method. The owners should not have doubts about the people working on the project. With design/build they have to let the design/build firm do its work. The owners have to be people that are capable of making decisions quickly in order to be able to cope with the tight schedule that design/build construction creates and to have the product delivered to them on time. Moreover the owners need to understand that 'in order for specific project goals to be achieved, the delivery system must be compatible with the owner's contracting methodology (e.g., lump sum, cost plus with GMP) and procurement process (e.g., direct selection, competitive best value)' [16, Loulakis]

Another reason why design/build does not work successfully is because the high quality expectations the owners have are not compatible with the procurement and the contracting preferences of the design/build firm. Procurement process is the process of finding what is needed as far as equipment and materials, for the project [16, Loulakis]. From the start the owners have to decide the criteria under which they will select the design/build firm. If the owners select a design/build team based on who provides the lowest price, the contractor might not have given necessary importance to the life cycle costs of the project and may not provide the quality that the owners have asked for. On the other hand, if the owners have selected a design/build firm based on the quality of the product they are promising to provide, then the owners must look at the firm's qualifications and must ask the firm to present alternatives for maintenance. Lastly, if the owners desire to have more control on the project as far as design goes, they should select the design/build firm based on its qualifications and that will provide a guaranteed maximum price (GMP) after the design has reached a stage where the owners understand how the product will end up looking like when constructed. If it is not clear from the beginning how the owners wish the project performance to be driven by, then most likely the design/build construction will not be a successful one to use for the project [16, Loulakis].

According to Michael Loulakis who is an attorney with Wickwire Gavin, P.C, a nationally recognized law firm that represents owners, contractors, design professionals and sureties in issues that are related to construction, he mentions in his article that the design/build projects that do not work properly are the ones when contractors are not

placed in the project from the beginning, when the contractors working in the design/build firm do not have any previous experience of working in a team with the designers, when the owner does not have the ability to make decisions and the bidders have no pre-qualifications.

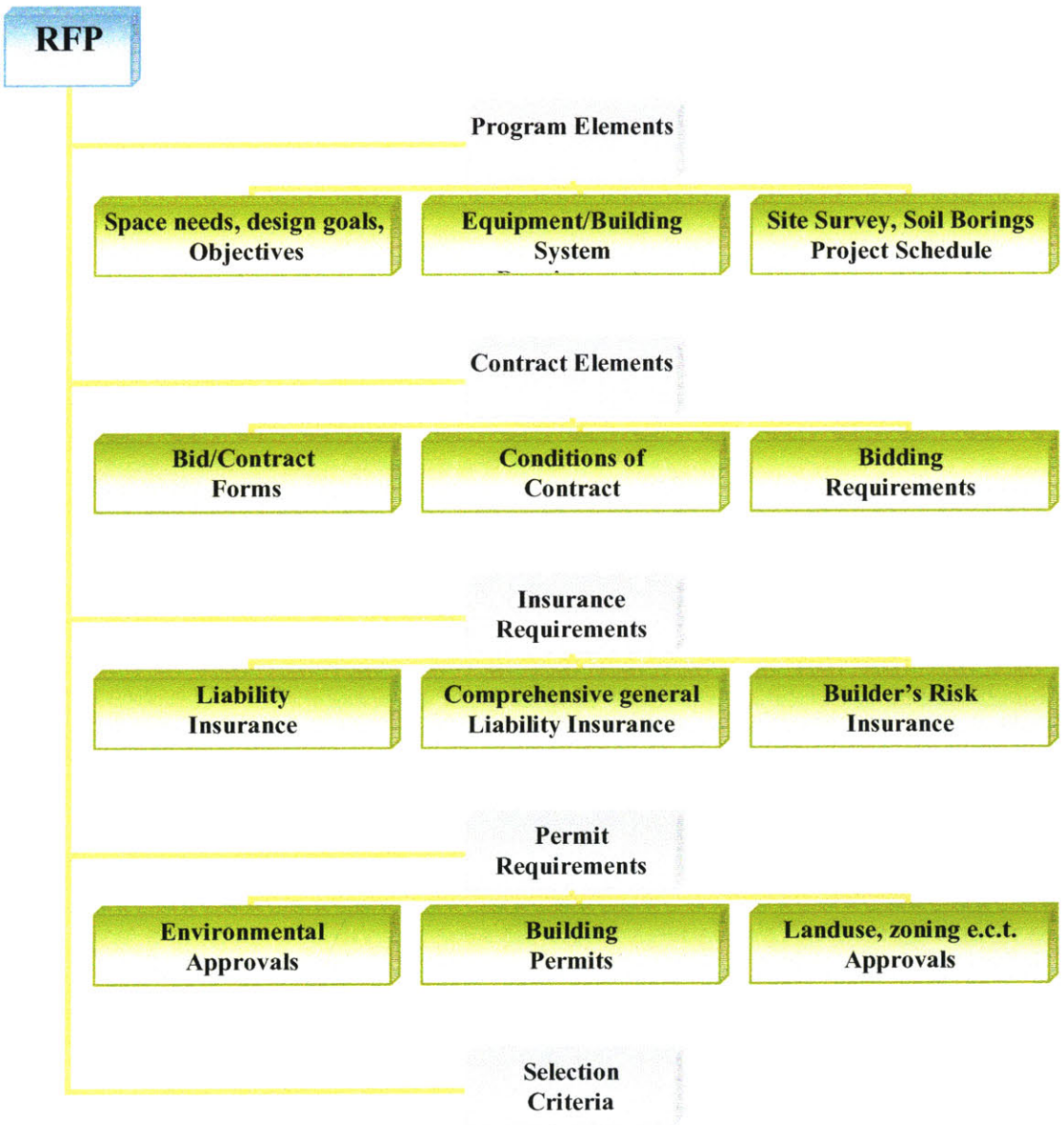
It is very important to hire people who have experience, not necessarily dealing with a design/build project, but working with other people and dealing with conflicts. The key for success in a design/build firm is cooperation and communication among the people involved. There has to be good communication between the owners and the people that compose the design/build entity as well as communication between the designer and the contractors within the firm. When design/build first started being used in projects, the problems were mainly due to the fact that the designers were not used to working with the contractors and visa versa. Also, they were probably used to a different pace in schedule.

Another reason why design/build does not work is because the Requests for Proposal (RFP) and all the technical documents are not prepared carefully. The Request for Proposal is a set of documents that include sketches of the design of the product, a list of the materials that will be used for the product and a description of the systems. Moreover a breakdown of the cost, schedule of construction and a contract proposal are included. If the RFP is not as specific as possible in describing the scope of the project, then design/build does not work successfully. RFP works like a set of rules that the

design/build firm needs to follow in order to achieve the quality and the aesthetics the owners expect after the project is completed.

For design/build a good amount of money is spent in order to prepare the request for proposal documents. Based on these documents the owner decides which of the competitor design/build firms will be used to execute the project. These documents prove to the owner that the contractor is capable of succeeding in the completion of the project. Some of the parts the Request for Proposal documents include, are shown in Figure 4.

Figure 4: Sections of the Request for Proposal (RFP)



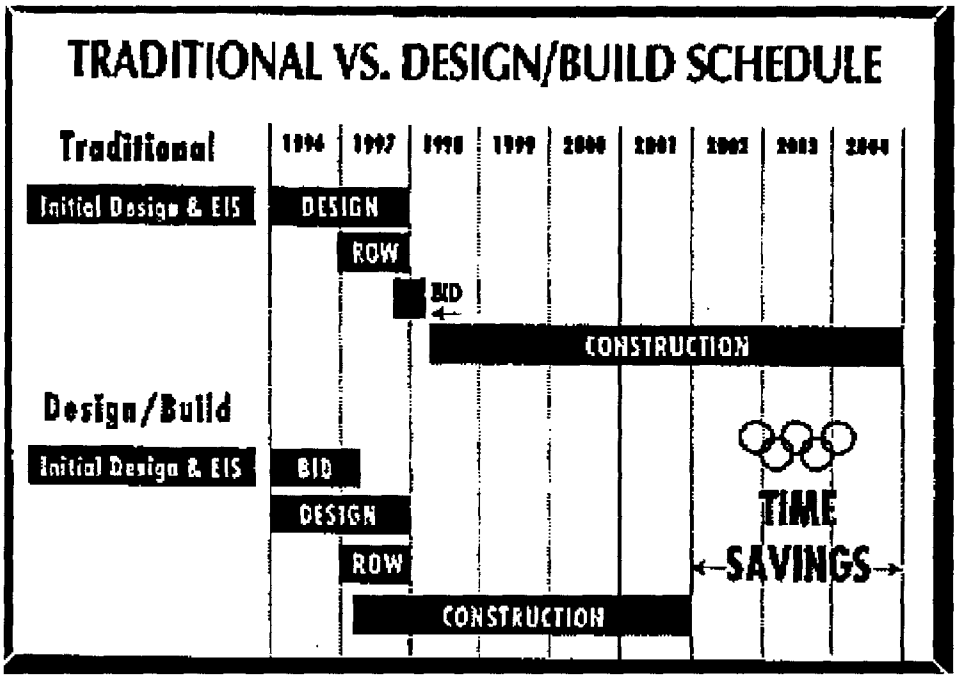
Chapter 5

Case Study on I-15 Design/build Project

In order to see how design/build works, how it is applied and what solutions are usually taken in order to avoid problems, a good way of doing that is by looking at a design/build project that used this delivery method. Even though the I-15 project was a successful design/build project, it is interesting to see what some of the problems were and how they were resolved in order to lead to a successful project. This chapter will be focusing on the reconstruction of the I-15 interstate highway in the Salt Lake City County in Utah [4].

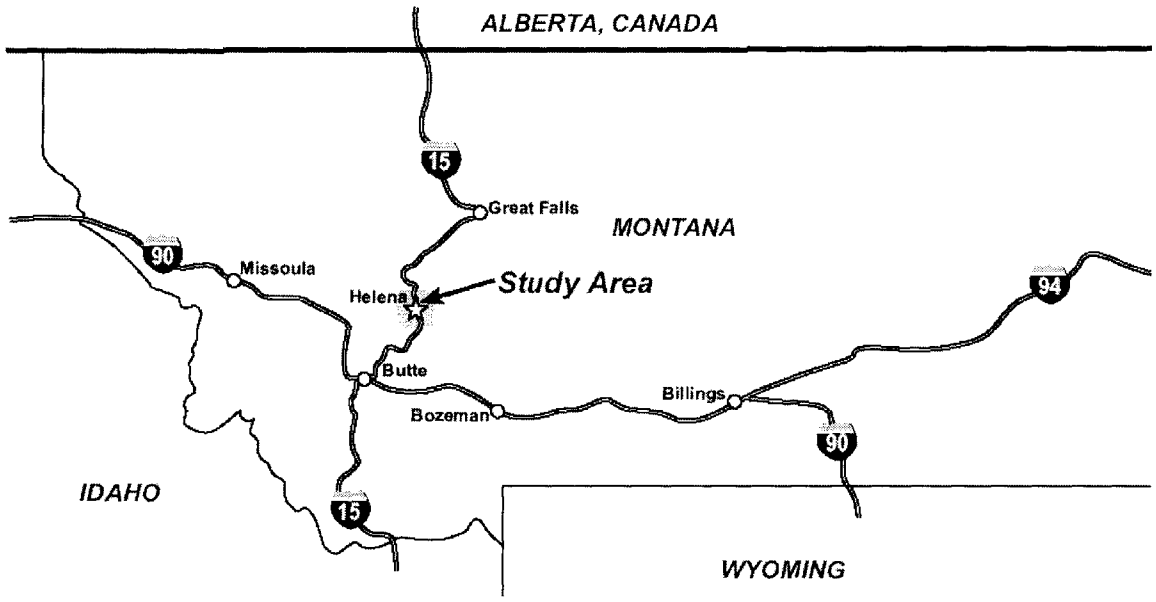
The increase in population as well as the deterioration of the system created a need to reconstruct the portion of the highway that covers the state of Utah. The company that was awarded the project was Wasatch Constructors in April of 1997. The delivery method that was initially going to be used was the traditional design/bid/build method but the fact that Salt Lake City was going to host the Winter Olympic games of 2002 created a need to have the project done quickly, in time for the games. A comparison between the traditional design/bid/build method and the design/build method regarding the schedule is shown in Figure 5. Design/build was chosen to use because the contractors could not think of another way to complete the project fast.

Figure 5: Traditional vs. design/build schedule [12]



The project involved replacing about seventeen miles of interstate highway together with one hundred and thirty structures, eight urban interchanges and three major freeway-to-freeway junctions where I-15 connects with I-90 and 1-94 as you can see in Figure 6. The project was divided into 20 sections because there was not enough money to fund the entire project from start. The goal of the project was for it to be completed sooner in order to avoid possible problems that would occur on the highway during construction, before the beginning of the winter Olympic Games [3].

Figure 6: Regional Location Map [13]



One of the issues with this project was the fact that it started out with one delivery method and then after six months it was switched to another delivery method. Switching to design/build is hard to do, especially when the people involved in the project do not have the knowledge and the expertise on this delivery method. When an owner is used to using the traditional design methods, it is hard to suddenly switch to another one. Distributing certain responsibilities related to the design to people in a company may be hard when this particular company is used to using the traditional delivery methods. This creates doubts to the owners who are concerned about the quality of the finished product when the contractor works together with the designer. The owners need to be informed and understand the risks that are connected when using design/build. When the owners see that the contractor is working together with the designer, because of the fact that the contractor is interested in profit and the designer is interested in quality, they are afraid that more attention will be paid to profit than to quality [3].

In order to avoid the problems, the owners must have strong leadership skills and be committed to the delivery method that is being used. They must be open-minded and accept any changes that might occur. The more informed the people involved in the design/build process are, the more likely will the problems be avoided and solutions will be found. With the I-15 design/build project, award fees were established in order to assure the quality of the completed product. The amount that was established in this project was about fifty million that would be paid in installments throughout the life of the contract and there was also an award of five million that would be given if the contractor completed the project sixty days before the promised date of completion [4].

One of the other conflicts that occurred with design/build in this project was related to the accelerated construction schedules. There were some conflicts between the contractors and the designer. One example is when the contractor asked for the design of the walls to be submitted earlier than scheduled. This led to problems because the designs were not developed enough to give the contractors an idea on how the walls should look like. This prevented construction items to be released to the contractors within the time frame that they wanted. The result of this was to have all the retaining walls on the critical path of the schedule of the project. Some of the details for the walls were shown on the designs, something that resolved some of the problems but not all of them. This clearly shows that the designers were not familiar with working with this delivery method. Experienced people would have known to what extent the designs needed to be done in order to give a clearer idea to the contractors about what they need to do. The designers involved in this project indicated that they wished they had more time to work on the designs before

giving them to the contractor, something which shows that they were not experienced in working on fast pace projects like this one [4].

Design/build projects have a fast pace which usually could lead to mistakes. In this project, the mistakes appeared in the development of standards and plans. The standards and plans for design give information on process standards and set the standards for the quality of the design plans, in order for all of them to have the same template and layout and to make sure those situations that were the same were done in the same way. With the I-15 project, the designers were working on the plans, before the standards were completed, something which resulted to a lot of changes in the designs that were completed in the beginning. This would have delayed the start of the project, but at least the time could have been used doing something else instead of redoing the plans all over again. In other projects, this could have affected the schedule and caused delays but with the I-15 project that was not the case.

In design/build, besides knowing how much of the design needed to be completed, it was also important for the designers to be aware of particular issues that might have affected the designs beforehand in order to avoid possible change orders. One of the problems that were encountered in this project was related to right-of-way issues. A detailed research on all the areas that would be impacted by this project was not done, something which created questions to the designers who were not sure if they were staying within the right-of-way boundaries. Detailed research had been done on the areas that particular parcels were required but for other areas, there was not enough information. This lack of

information resulted to insecurity for the design/build team, which increased the risk for Wasatch Construction, the design/build firm for this project. They were responsible for right-of-way and they would be the ones paying for any additional cost regarding this issue and in charge of any delays that might have occurred throughout the project to resolve these issues. In general, the lack of information is an important problem in design/build construction and can lead to serious consequences [4].

Value Engineering was another issue on this project. According to the website "Cambridge Online Learning", "value engineering is an organized approach to providing the necessary functions at the lowest cost [14]." This was something that could not be done in this project and in most design/build projects since there was pressure in time. Any changes that were going to be done in the plans that were proposed in order to apply value engineering, would have delayed the project because more time would have been needed for construction. The delays in the schedule for this project were more important than the money that would have been saved. Any changes that required more time than what the schedule indicated were not implemented, even if a good amount of money would have been saved on the project. The fact that there was no reward for subcontractors for applying value engineering did not motivate them to spend time applying it on the project. The only important thing in this project was to complete before the start of the winter Olympic Games [4].

Another problem that was encountered with this delivery method is that there was really not enough time to do constructability reviews. The fast pace of the project did not allow

Wasatch Construction to have as many constructability reviews as they wanted. If this were permitted, there would have been some improvements in the design. Audits on the other hand were done quite frequently (at 30%, 65%, 90% and 100% of completion of the design) but it was realized that audits done that frequent were not necessary since the designer and the contractor work pretty close together and the time period between the design and the construction was not small, which allowed less mistakes to be made. For future projects, audits would be made at 50% and 100% of completion of the project [4].

One of the aspects of the project that worked really well for design/build was the use of partnering. Wasatch Construction partnered with the Department of Transportation of Utah (UDOT) in order to help "handle and resolve issues. The emphasis of the partnering process was to enable resolution of issues and problems at the lowest level possible in the project organization and in a timely fashion [4]." When problems are resolved and dealt with more efficiently, then delays of activities are minimized and delivery method serves its purpose. The Department of Transportation of Utah as well as Wasatch Construction believes that one of the reasons this project was a success despite some problems that occurred, was because of the partnering process. They feel that if it were not for partnering, the project would not have been as successful as it was.

When two companies partner, it is similar to creating a team. The purpose of partnering is to create productive and efficient working relationships between the companies involved in large construction projects. The companies that have a partnering relationship are usually those that have the same goals and objectives, that trust and respect one another,

that share equally the risks and the rewards in a project and that are interested in satisfying the client. The parties that are usually involved in partnering are the owners, the designers, the contractors and the subcontractors [7]. In Europe partnering is necessary because it is not allowed for one company to take a design/build project by itself. It has to partner with another one. The reason for that is if something goes wrong, the two companies equally share the responsibility. If they are not partners, then one would blame the other and lead to disturbance of the design/build process whereas if they are partners, they have no right to argue and cause conflicts because the two companies have signed a contract that indicated each company's responsibilities and roles.

An example where one can see how partnering worked well in the I-15 project, was with the north end of the project. The Department of Transportation gave the contractor the designs to construct the interchange and railroad overpass in order to start construction earlier but a number of problems had occurred. There were claims that were a result of different conditions such as excessive settlement, changes that were made to the original designs as well as other issues that were related to the construction of the project. A partnering session took place in order to find solutions to these problems. The solution that was found was to create an agreement that would include the methods that should be used in order to give solutions to the problems that were related to changes done to the original designs. Basically, this agreement described the process that needed to be followed in order to avoid issuing a change order or claim. Because of this agreement, no claims were made on the project [5].

The I-15 project, despite the various problems that the project delivery system led to, it was a successful design/build project. It ended up being completed about sixty days earlier than scheduled and under budget. The people involved in the project, ended up learning a lot about design/build, especially from the problems that occurred and the mistakes that were made.

Chapter 6

Summary and Conclusions

Design/build lately has been a deliver method that has been selling a lot; a method that is promoted from a good number of companies on the web. It is a delivery method that contractors use in order to shorten the amount of time needed to complete a project, but to also complete the project with less amount of money and sometimes even under budget. It is a method that has been successfully used with large projects that could be broken up into different phases. It is a delivery method that provides information of the cost of the project before hand. Just like machines, no matter how many things they can do and how good they are, if they are not used correctly, people cannot get positive results; the same exists with design/build. Even though there is a list of advantages this project delivery method has, if it is not used for the appropriate projects, then the list of advantages could easily turn into a list of disadvantages and problems. There is no right or wrong delivery method. There is though a right or wrong project for a delivery method.

This thesis basically described the characteristics a project and the people involved in the project need to have in order to lead to successful results. The author of this thesis analyzed what existing situations lead to problems when design/build is used. The situations created were a result of the relationship between the parties involved in the

project such as the designers, the owners and the contractors. Also problems related to the bidding process, licensing, insurance and bonding were discussed. Moreover, the risk that the parties of the design/build team were mentioned and the concerns the owners have with the quality of the end product were discussed. For the disadvantages, some solutions to the problems created were recommended and an application of the disadvantages was shown though a case study of the I-15 design/build project.

Everyone learns from the mistakes and from problems. Once design/build becomes allowed in all of the states in the United States, once this delivery method becomes popular, it will be used more and more and people and companies will become more familiar with it and will use it with less and less consequences. Educating the people about design build will help them understand the delivery method better and will help them better judge whether or not the project they want to bid on and work on will be the appropriate one. There is no competition between the delivery methods. Just because one method is used a lot, that does not mean that it is the ideal one for a project. It is important to spend a good amount of time examining the conditions and circumstances that exist for a specific project, look into the pros and cons of possible delivery methods for the project and then at the end decide which one to use. An important factor in this decision is for the owners to have cleared what exactly is it that they want out of the project. Depending on what the expectations are, the suitable delivery method could be used. Once the appropriate delivery method is carefully selected, the project is more likely to be completed successfully.

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